



Goddard Space Flight Center

# GSFC NASA ADVISORY

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| <b>1. Advisory Number</b><br>NA-GSFC-2003-03 | <b>2. Subject</b><br>Fluoropolymer Degradation Resulting in Corrosion of Packaged Pre-wired Connector Assemblies. |
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| <b>3. Manufacturer</b><br>Various | <b>4. Manufacturer CAGE Code</b><br>Various | <b>5. Federal Stock Code</b><br>N/A |
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| <b>6. Part/Material/Process</b><br>Various | <b>7. Lot Date Code/Batch Code/Serial</b><br>N/A | <b>8. Controlling Spec/Document Number</b><br>16878, 22759, 24308, 55302, 83513. Not inclusive list. |
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**9. References** 34<sup>th</sup> International SAMPE Technical Conference: "Cause and Effects of Fluorocarbon Degradation in Electronics and Opto-Electronic Systems". ISBN Number: 0-938994-93-X.

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**11. Problem Description and Details:**

This general Advisory addresses corrosion concerns for connectors (especially microminiature and nanominiature types that have a metal shell) that are terminated with fluoropolymer insulated wire, such as radiation cross-linked Ethylene-Tetrafluoroethylene (XL-ETFE), and stored in sealed plastic/metal bags for several months or longer.

A metal shell connector assembly was found with a corroded connector shell and corroded connector contacts after it had been stored in its original sealed bag for more than two years after date of manufacture. This connector assembly consists of a pre-wired nickel plated metal shell connector terminated with a quantity of 37 XL-ETFE wires, each measuring 36 inches in length. A review of the purchase order documentation found that the connector assembly was from a lot that had a certificate of conformance dated Feb. 2000. According to this certificate, the connector had acceptable attributes. The corroded pre-wired connector assembly was forwarded to the Goddard Materials Lab for a failure analysis. See the failure analysis results in the "Materials Lab Findings" section on page 2.

Furthermore, corroded pre-wired connectors built to specifications 83513/3 and 83513/4 were found in plastic bags after having been stored for two years.

*Continued in section 11 of page 2.*

**12. Action Taken:**

As a precaution for all flight hardware with pre-wired connector assemblies, the following mitigations are recommended:

- Projects should inspect the connectors upon receipt (both the shell and contacts) using appropriate magnification to verify that there is no corrosion. The existing inventory of pre-wired connector assemblies should be reinspected. In addition, all assemblies should be inspected before use. Inspect for darkening of the shiny metal surfaces. All connector interfaces should be covered with protective dust covers. For assemblies that have already been integrated into flight hardware and that were inspected and found to be acceptable before mating, there should be no concern for subsequent malfunction.
- The pre-wired connector assemblies should be removed from sealed bags and stored in open packages that will allow any reactive fluorine compound (s) to escape. Connector assemblies should be stored in a controlled humidity environment. The preferable storage area for pre-wired connector assemblies would be in a dry nitrogen atmosphere.

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| <b>16. Released by: (Signature)</b><br><i>Original signed by</i><br><u>GSFC NASA Advisory Coordinator</u> | <b>OFFICIAL USE STATEMENT: Only signed and dated versions of this Advisory are to be used for official reference purposes.</b> | <b>17. Date Released</b> |
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**1. Advisory Number**  
NA-GSFC-2003-03

**2. Subject**  
Fluoropolymer Degradation Resulting in Corrosion of Packaged Pre-wired Connector Assemblies.

**11. Problem Description and Details:** *(Continued from page 1)*

**Materials Lab Findings:**

Using Electron Spectroscopy for Chemical Analysis (ESCA) analysis, the Goddard Materials Lab determined that the corrosion product on the connector pins was a mixture of non-conductive copper fluoride and copper oxide. The gold plating on the pins was no longer present and the pins were no longer conductive.

Using X-Ray Photoelectron Spectroscopy (XPS), the Goddard Materials Lab examined the wiring harness connector and determined that the corrosion products were a mixture of nickel fluoride and nickel oxide. The nickel oxide and nickel fluoride allowed continued corrosion penetration, resulting in discoloration of the connector along with particle generation.

**Discussion on Corrosion Chemistry:**

During the manufacturing of fluoropolymer insulation for wires, processes such as the extrusion of fluorocarbon resins occur at a temperature high enough that oxidative degradation of the polymer will occur in the presence of air or water. Such processing of fluoropolymer resin in the presence of air or moisture results in the release of a number of materials, including carbonyl difluoride, an extremely reactive compound. The outgassing of carbonyl difluoride is not in violation of any military or commercial wire specification requirement. Carbonyl difluoride hydrolyzes in the presence of trace moisture to generate carbon dioxide and hydrogen fluoride. The hydrogen fluoride will then hydrate to form concentrated hydrofluoric acid, which is a corrosive agent that reacts with metal and metal oxides.

The corrosion of the electroless nickel shell plating is the result of the exchange of surface oxygen in the surface nickel oxide layer with fluorine in the hydrofluoric acid, resulting in a dull looking surface of nickel fluoride.

For gold plated contacts, the porosity in the gold plating allowed hydrofluoric acid to attack the underlying copper, resulting in several copper compounds on the contact surface.

The Society of the Plastics Industry publishes the "Guide to the Safe Handling of Fluoropolymer Resins, Third Edition". Although this publication is directed at maintaining safe working conditions within polymer processing facilities, it provides a basis for minimizing the generation of carbonyl difluoride and the subsequent hydrogen fluoride. This publication recommends the drying of polymer resins by pre-heating the resins under a dry nitrogen purge prior to extrusion to minimize the generation of carbonyl difluoride.

**Review of Technical Literature on Corrosion of Pre-wired Connector Assemblies:**

More information is available in the technical paper "Cause and Effects of Fluorocarbon Degradation in Electronics and Opto-Electronic Systems" that was presented at the 34<sup>th</sup> International SAMPE Technical Conference.

**12. Action Taken:** *(Continued from page 1)*